TRANSLATION OF KANSAS BACTERIA TMDL TO TRADITIONAL TMDL

The traditional notation of a TMDL is:

TMDL = WLA + LA + MOS or TMDL or $\sum$WLA + $\sum$LA + MOS, for multiple sources, where:

TMDL is the loading capacity of the stream; WLA is the Wasteload Allocation for the point source(s); LA is the Load Allocation for the non-point source(s) and MOS is the Margin of Safety.

This notation implies a steady state; i.e.; loading at a single flow value (7Q10, Q avg). The Kansas approach, however, recognizes the dynamic state of loads; e.g. loading varies directly with flow. Therefore,

$TMDL_i = WLA_i + LA_i + MOS_i$; at a given flow duration position, i. The load duration curve developed for bacteria, which represents the TMDL, is a cumulative frequency curve of each individual $TMDL_i$, since $TMDL_i = Q_i \bullet WQS \bullet C$, where Q_i is the flow associated with the ith exceedance position on the frequency curve, WQS is the applicable water quality criterion (900 for primary, 2000 for secondary) and C is the conversion factor necessary to create a "load" of bacteria colonies per day.

For the entire curve:

$$\sum_{i=99}^{10} TMDL_i = \sum_{i=99}^{10} WLA_i + \sum_{i=99}^{10} LA_i + \sum_{i=99}^{10} MOS_i;$$

Now, for wasteloads from point sources:

$$\sum_{i=99}^{10} WLA_i = \sum_{i=99}^{10} (P_i \bullet Q_i \bullet WQS \bullet C),$$

where Pi is the index of whether point sources are an influence on water quality which is a function of the designated low flow, Q_L. Q_L is the greater of the 7Q10 or 10 times (occasionally less) the sum of the design flows of the existing point sources in a watershed. This delineation is a reasonable estimate of the flow condition beyond which point source loading (from actual WWTP discharges) has negligible effect on ambient stream quality. The Q_L accounts for future growth since actual wastewater discharge is typically less than treatment plant design flows for many years to come. L is actually the exceedance position on the flow (or load) duration curve associated with Q_L. Designation of this low flow caps the amount of flow emanating from point sources at 10%, and typically the percentage is less. Flows lower than Q_L are influenced by point source flows, those above, are not. Therefore

for $i \geq L$, $P_i=1$; for $i<L$, $P_i = 0$

For this notation, higher flows relate to lower i values, e.g.; baseflow occurs at i = 85-99; runoff

occurs at i = 10-50, etc. This approach combines all the point sources into a single value. If allocation of "loads" were to be done for individual point sources, the allocation would be proportion to each source's design flow since the WQS (expressed as a permit limit) and C woud be the same for each discharger.

Similarly, for non point sources,

$$\sum_{i=99}^{10} LA_i = \sum_{i=99}^{10} (N_i \bullet Q_i \bullet WQS \bullet C),$$

where Ni is the index of whether non-point sources are an influence on water quality which is the case for flows higher than the designated low flow, Q_L. Therefore,

for $i > L$, $N_i=0$; for $i \leq L$, $N_i = 1$

The Load Allocation is bounded on the upper end by the flow exceeded 10% of the time. This high flow exclusion is recognized in the surface water quality standards.

The Margin of Safety, MOS, represents a hedge against the uncertainty in attaining the water quality standards. For Bacteria, the MOS is 100 colonies/100 ml below the applicable water quality criteria, therefore, the true evaluation would come from comparing samples to values of 800 colonies per 100 ml for Primary Contact Recreation and 1900 colonies per 100 ml for Secondary Contact Recreation. The associated load which accounts for the MOS would be:

$MOS_i = Q_i \bullet 100 \bullet C$; and across the entire TMDL curve

$$\sum_{i=99}^{10} MOS_i = \sum_{i=99}^{10} (Q_i \bullet 100 \bullet C)$$

The resulting load duration or TMDL curve would be:

$$\sum_{i=99}^{10} TMDL_i - \sum_{i=99}^{10} MOS_i = \sum_{i=99}^{10} WLA_i + \sum_{i=99}^{10} LA_i \text{ ; or,}$$

$$\sum_{i=99}^{10} (Q_i \bullet (WQS-100) \bullet C) = \sum_{i=99}^{10} WLA_i + \sum_{i=99}^{10} LA_i$$

This relationship is described on each TMDL graph. A vertical line is drawn through the TMDL curve at exceedence L, the point demarcating the influence between point and non-point sources. If one integrated the area under the curve, the result would be the total load occurring 100% of the time. The percentage of the area to the left of the vertical line is the Load Allocation; the percentage of the area to the right of the line is the Wasteload Allocation.

This procedure delineates the flow condition or regime by which point or non-point sources are responsible for effecting pollution reduction such that future samplings do not rise above the TMDL curve (accounting for the parallel line offset from that curve and representing the Margin of Safety).